## Dublin Institute of Technology

| Pre-requisite module code(s) | Co-requisite module code(s) | ECTS credits | Module code | Module title | Revision date |
|---|---|---|---|---|---|
| | | 5 | NIMT 1001 | Antennas – Design and Technology | 17.01.12 |

### Module authors:

Dr Steve Best, Prof Vince Fusco, Prof Max Ammann

### Module Description:

This module is an introduction to modern Antennas – Design and Technology

### Module aim:

The aim of this module is to provide a broad understanding of antenna theory, design and practice with respect to real world wireless communications systems and devices and to understand the building blocks and design process for fundamental antenna elements

Modelling,

### Learning Outcomes:

On completion of this module, the learner will be able to:

• Describe fundamental and advanced concepts associated with antenna design, performance and operation within real world environments

• Identify a broad spectrum of antenna types used in today's wireless communications markets

• Evaluate properties of antennas with a detailed knowledge of factual and fundamental antenna theory

• Evaluate advanced performance trade-offs associated with antenna design

• Use advanced electromagnetic simulation software and model a family of antenna types.

• Design antenna elements for modern wireless systems

• Discuss the theories associated with the implementation of phased array antenna systems

• Describe how antenna performance and the RF propagation environment impact wireless communication system performance

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### Learning and Teaching Methods:

This module will be delivered as a series of lectures supported by laboratory exercises.

### Module content:

**Basic Antenna Concepts**

• Definitions of basic antenna properties: impedance, VSWR, Q, bandwidth, directivity, gain, radiation patterns, polarization, etc.

**Types of Antennas**

• Resonant antennas • Traveling wave antennas • Frequency Independent antennas • Aperture antennas • Phased arrays • Electrically small antennas • Circularly polarized antennas

**Classification of Antenna Types**

• By frequency • By size • By directivity

**Fundamental Antenna Elements**

• The monopole • The dipole • The loop • The folded dipole • The slot

**Microstrip Antennas**

• Element types • Microstrip element design • Design trade-offs • Designing an 802.11 microstrip patch

**Baluns**

**Ground Plane Considerations**

• Vertically polarized antennas • horizontally polarized antennas • The impact of the surrounding environment on antenna performance

**Circularly Polarized Antennas**

• Achieving circular polarization • The helix antenna • The crossed dipole antenna • The microstrip patch • The quadrifilar helix

**Aperture Antennas**

• Aperture design concepts • The horn antenna • The reflector antenna • The corner reflector

**Impedance Matching**

• Impedance matching networks

**Broadband Antennas**

• Monopole configurations • Feed considerations • Dipole configurations • Bandwidth improvement techniques

**Frequency Independent Antennas**

• The log-periodic antenna • The spiral antenna

**Electrically Small Antennas**

• Impedance, bandwidth and quality factor of antennas • Defining electrically small • Fundamental performance limitations • The small dipole • The small loop • Design and Optimization of small antennas

**Antenna Arrays**

• Fundamental array theory • Types of antenna arrays • Feed network design considerations • Beam steering and shaping concepts • Performance trade-offs • Microstrip patch arrays • Dipole element arrays • Digital Beamforming

**Friis and Radar Range Equations**

• The communication link • Understanding and calculating path loss

**Receive and Scattering Properties of Antenna**

• How does an antenna capture power • Aperture area and efficiency • Coupling between antennas • Antenna noise temperature

**Fractal Antennas**

• Fractal antenna types • Performance properties of fractal antennas

**RFID Antennas**

• RFID system basics • Performance properties of RFID antennas

**Ultra Wideband (UWB) Antennas**

• Time domain considerations in antenna design • Antenna performance requirements in UWB systems

**Low Profile Antennas**

• The inverted L and inverted F antennas • The planar inverted F antenna (PIFA)

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**Device Integrated Antennas**

• Antennas commonly used in wireless device applications

**Electronic Bandgap Materials**

• What are EBG materials? • Limitations of perfectly conducting (PEC) ground planes • Advantages of EBG ground planes

**Numerical Modeling of Antennas**

• Software packages • Comparison with measurements

**Propagation Channel Considerations**

• RF path loss • Reflection, multipath and fading • Noise and interference • Polarization distortion • Diversity implementation

**Types of Antennas used in Communications Systems**

• Wireless base station antennas • Wireless handset and portable device antennas • GPS antennas • HF, UHF and VHF communication antennas • Earth station and satellite communication antennas

**Laboratory work**

- **Introduction to electromagnetic modelling**
- **Antenna design and modelling**
- **Antenna prototyping**
- **Antenna measurements**

## Module Assessment:

Students' performance in reaching the learning outcomes for this module will be assessed by

(1) Laboratory, accounting for 25% of the overall mark and is continuously assessed throughout the module.

(2) Assignments accounting for 25%

(2) Written examination at the end of the Module, 2 hour exam, accounting for 50% of the overall module mark.

The pass mark is 40%

## Essential reading:

Text:

Antenna Theory – Analysis and Design, C. A. Balanis ISBN : 0-471-66782-X

Foundations of Antenna Theory and Techniques: Vincent F Fusco: Pearson Education, Prentice Hall, ISBN 0 130 26267 6, 2005.

## Supplemental reading:

Antennas - John Kraus, Ronald Marhefka, ISBN: 9780071122405

## Further Details:

Duration of module: 1 week contact +pre-requisite study+ assignments + exam

Pre-requisite independent study 15 hours

Contact hours: 20 hrs lectures

Laboratory work 15 hrs

Assignmernts 10 hrs

Exam independent study 10 hrs

Date of Academic Council approval ……..